Fig. 5. Left wing, dorsal aspect, of an adult *Asio accipitrinus*, to show the typical, adult, diastataxic wing. Note the absence of a remex between the 5th pair of major coverts, and the marked gap between the 4th and 5th remiges.

PLATE 15.

Fig. 1. Right wing, dorsal aspect, of an embryo *Columba domestica*. This is markedly diastataxic. The shifting of the coverts is very distinct. Compare Pl. **16.** fig. 1.

Fig. 2. Right wing, dorsal aspect, of an embryo *Lomvia troile*, at present eutaxic; but a study of the coverts shows that a shifting has commenced, the result of which ultimately *reduces the wing to the typical diastataxic form*. Compare this with the figure on p. 243, which shows the condition of the wing in the downy nestling.

The figure immediately below is drawn from fig. 2 to show the effect of a slight increase in the shifting of the coverts transforming the wing from the eutaxic to the diastataxic type, as seen in fig. 1.

Fig. 3. Right wing, dorsal aspect, of an embryo *Anas boscas*, var. *domestica*, decidedly diastataxic. No earlier stages were procurable.

PLATE 16.

Fig. 1. Right wing, dorsal aspect, of a nestling *Columba domestica*. Note the intercalary row of coverts, and compare with fig. 1, Pl. **14.**; also the large size of the major coverts of the forearm as compared with the cubital remiges (1st *c.r.*), which have as yet only just begun to project beyond the surface of the wing.

Fig. 2. Right wing of adult *Opisthocomus*.

---

## On the Discovery and Development of Rhabdite-"cells" in *Cephalodiscus dodecalophus*, McIntosh.

By F. J. COLE, University College, Liverpool. (Communicated by Prof. G. B. HOWES, Sec. Linn. Soc.)

[Read 6th April, 1899.]

(PLATE 17.)

A SHORT while back Professor Herdman was kind enough to place in my hands some small pieces of *Cephalodiscus* for treatment and sectioning by modern microscopical methods. As interest in this unique form has been again aroused by the recent work of Masterman *, it was proposed to revise the whole anatomy of the polypide besides investigating the few points which a consideration of the literature showed to be unsettled.

* Q. J. M. S. vol. xl., 1897; Trans. R. S. Edin. vol. xxxix. pt iii., 1898.

So far, the results are the bodies described in the present communication, a *possible* true sense-organ in the region of the gill-clefts, and a large and undoubted gland situated on the proboscis *. Descriptions of the two latter are left over for the present. Of the material at my disposal sections were cut in various planes and treated by various methods. The whole cœnœcium with the contained polypides was sectioned, as well as also individual polypides orientated by the dissecting-microscope in paraffin. The latter process, owing to the size of the individuals, is by no means difficult, so that it is not necessary to resort to Patten's method. So far as the purposes of the present paper are concerned, the only method of staining found to give really satisfactory results is Dr. Gustav Mann's excellent combination of methyl-blue-eosin †. The sections were stretched on a slide previously treated with Paul Mayer's albumen-fixative and covered with a film of water, and then stained on the slide according to the directions given by Dr. Mann. Successful preparations *that have not been over-stained* (when properly decolorized for the rhabdites the general tissues are almost unstained) show a perfect differentiation of the rhabdite-"cells," so that their structure is somewhat easily followed by examination with Zeiss's 1·5 mm. apochromatic lens in conjunction with the compensating eyepiece No. 12.

## Historical.

As is well known, after the return of the 'Challenger' Expedition, the bottle containing the specimens of *Cephalodiscus* obtained in the Straits of Magellan was sent, with the collection of Tunicata, to Prof. Herdman. It then bore a label in the writing of the late Prof. Moseley, stating that the animal was a "compound Ascidian." Prof. Herdman examined it in the winter of 1879–80, and mounted some preparations in different ways (including the material referred to above), sufficient to determine that it did not fall strictly within the group Tunicata, and that its affinities were rather with what are now considered the other Protochordata. He returned the stock to Sir Wyville

* This apparently is not the structure referred to by Harmer (Zool. Anz. 1897), and I am not yet in a position to state its relation to the proboscis-gland of *Balanoglossus*.

† Journ. Anat. & Phys., vol. xxix.

Thomson, with a statement that he did "not consider it a compound Ascidian, but rather an aberrant Polyzoan related to *Rhabdopleura*." As a result the animal was at once forwarded to the late Mr. George Busk, and after that to Prof. McIntosh, as stated by the latter in the 'Challenger' report on *Cephalodiscus* (p. 3). The material I have used is a few fragments made use of by Prof. Herdman in his first determination of the probable affinities of the animal.

---

As described by Professor M'Intosh in his 'Challenger' report, the branchial plumes "are nearly of uniform size, and consist of a thickish central stem, occasionally slightly crenate, and furnished with a series of longitudinal fibres; while distally each is terminated by a peculiar bulbous enlargement, which at first sight resembles the tip of certain hydroid tentacles (e. g. *Coryne* or *Syncoryne*) bristling with dart-cells and pigment. The rugose appearance, however, is due to large gland-cells containing granules and globules, which are arranged in a somewhat regular manner round a central cavity, and which present a deep yellowish tint in the preparations. This structure may perhaps be a further and special development of the somewhat large hypodermic granules of the tips of the pinnæ." Elsewhere McIntosh states that the bulbous enlargements of the plumose arms may secrete the "spinous processes or fimbriæ" on the surface of the cœnœcium. Although McIntosh did not succeed in elucidating the nature of the "large gland-cells," his description above, as far as it goes, and excepting perhaps the last statement, is quite correct.

Masterman's interpretation of the bulbous enlargements (which may be conveniently termed "rhabdite-batteries") is that they represent "a dozen large eyes of a very primitive compound type." As this conclusion is so directly opposed to the explanation given in this paper, it is perhaps as well that the evidence on which it is based were summarized. It is as follows:—

1. "If the parts be subjected to partial maceration the clear globules [inside the gland-"cells"] can be obtained free, and they remind one irresistibly of a crystalline refractive lens."

2. "All [the gland-'cells'] have fine pigment granules scattered throughout their interior, and a great number of them contain the crystalline lenses referred to."
3. The base of the "eye" is believed to have been "in some cases traced into the main nerve of the plume."
4. "The whole structure here described seems to indicate that these organs are rudimentary monostichous compound eyes, which bear a remarkable resemblance, both in appearance and structure, to the 'branchial organs' found in the sedentary Annelids, such as *Potamilla* and *Sabella* . . . . . It seems most reasonable to regard them tentatively as primitive eyes, though the presence of compound eyes in the Chordata is rather remarkable."

First, as regards matters of fact, I find myself unable to confirm the statement as to pigment in paragraph 2, the existence of a nucleus as shown in the figure, and also the belief as to the nerve-supply in paragraph 3. Further, fig. 30 in Masterman's paper is, I must confess, quite unlike anything I have seen. In all my sections the wall of the battery is considerably vacuolated, and I have never seen the cells closely opposed as shown in this figure (*cf.* my fig. 1).

Second, as to matters of interpretation, passing over the insufficient nature of the evidence on which Masterman bases so important a statement, the finer structure of the bodies in question as here described must, assuming the accuracy of the description, be held to negative the view which Masterman has stated.

In his later paper (*op. cit.* p. 521) Masterman, in referring to the blastogenesis of the plumes and pinnæ, says: "The plumes arise throughout in pairs. They first make their appearance as a papilla, which elongates to a finger-shaped process, the distal extremity of which becomes slightly swollen, and then bulbous. The epithelium of this bulbous extremity then becomes modified to form the eyes. The cuticle of certain of the epithelial cells becomes thickened, and soon the thickening protrudes into the cavity of the cell as a lens-like body. Later it is detached from the cuticle and lies freely in the protoplasm. Here it becomes rounded off to form the lens." In plate iv. figs. 75, 76, & 77, this process is illustrated, showing the nucleus of the "eye" at first peripheral in position, and afterwards thrust down to the basal

extremity of the cell by the ingrowing cuticle. As I have not investigated the blastogenesis of the rhabdite-"cells,". I am not in a position to express an opinion as to the accuracy of the above statement. I can, however, assert that a true cuticle is *not* present on the free surface of the rhabdite-battery of the adult, although a peripheral deeply-staining membrane is often seen, but this is not a cuticle. That it would be noticed if present in my sections is shown by the fact that the axis of each branchial plume has a cuticle which is quite obvious, but with one exception, when it was traced on to the base of the battery, this is always seen to stop short of the knob of the battery. Indeed in some sections, which were kindly placed at my disposal by Prof. Howes, indications were not uncommon of a few rows of cells situated external to what I have supposed is the free surface of the battery, *i. e.* the surface bounded by the supposed cuticle. It is possible these may represent a true epidermis which has been lost by the maceration of the material, although it seems very improbable that it would have been lost in by far the greater majority of the batteries. The existence of such a layer is, however, rendered conceivable by the position frequently assumed by the immature rhabdite-"cells," and also by the usually ragged and seemingly artificial free border of the enlargements themselves.

### Description of the Rhabdite-"cells."

The occurrence of the "cells" of the rhabdite-batteries on the branchial stems has been correctly described and figured by McIntosh, so that it is not necessary to recapitulate it here. A close examination of the rhabdite-"cells" in a number of specimens discloses two important and significant facts: (1) No two "cells" are ever exactly similar—hence they are "cells" in which a great amount of metabolism is going on; (2) there are two extremes of position—(*a*) near the basal cells of the battery, and (*b*) absolutely outside the battery and lying on its surface. These two extremes of position are bridged over by the necessary intermediate stages. These two observations alone justify us in concluding—(1) That the "cells" are engaged, and actively engaged, in secreting something, and are hence of a sort gland-cells; (2) that that something is a body which, to serve its purpose, must be cast on to the exterior. Similarly, the observations at once preclude the possibility of the "cells" being sense-organs

of any sort. They are not excretory organs, as their position and structural relations imply, and they do not store up food-material like the sacculi of the Crinoids, as the products of the "cells" are (at least often) ejected on to the exterior. But since, on the other hand, the ultimate products of these bodies are a number of pointed or somewhat blunt rods, since the metabolism of the "cells" is always in the direction of the production of these rods, and since finally these rods can in some cases be seen in the various stages of being, by the rupture of the "cell," shot on to the exterior, the only structures with which the "cells" can be compared are clearly the rhabdite-cells of Turbellaria and Trematoda, and the less specialized bodies found in the integument of Nemerteans. They will have the same function doubtless as the rhabdite-cells in the latter groups, whatever that is, and they are produced in *Cephalodiscus* by the following series of changes.

It is first necessary to describe the structure of the wall of the battery itself (fig. 1). Such a description is necessarily based on the material as I found it, and is thus liable to a percentage of error due either to post-mortem changes or imperfect fixation or both. Figure 1 is a drawing of a portion of the wall of the battery which, after a prolonged search, seemed to have been most favourably preserved and cut accurately at right angles to the surface. The cavity of the battery (*10*) is lined by a series of occasionally nucleated fibres (*8*), which are doubtless the direct continuation of the longitudinal fibres of the stem described by McIntosh. Many of these fibres have snapped in fixation (*9*), giving the appearance under ordinary lenses of a row of large cilia projecting into the cavity. Situated on these fibres is a single row of large irregular cells (*4*), each containing at least one undoubted nucleus. In some preparations it can with certainty be made out, as shown in the figure, that the cells are continuous at the base, so that a perfectly continuous layer of protoplasm surrounds the longitudinal fibres (*5*). From this layer of protoplasm there occasionally passes a long filament (*7*) which lodges one or more nuclei, and passes straight upwards to anastomose with the free surface of the battery (*1*). Similar filaments, which are however much more numerous, and also lodge nuclei, pass from the basal cells themselves to the surface (*6*). Whether either one or both series of filaments represent the narrow interstitial cells described by Bürger as being

wedged in between the "pseudo-rhabdites" of Nemerteans is a possibility which only perfectly preserved material can determine. The three interesting features therefore about the basal cells are:—(1) Their protoplasm is continuous proximally; (2) they are separated by distinct intervals from each other, and present an almost amœboid appearance; (3) they are connected by one or more nucleated filaments with the periphery of the battery. Lying in the spaces defined by the latter filaments are the rhabdite-"cells" themselves (*3*)—to be described below. The varying position and structure of these bodies may be noted here. The periphery of the battery is often defined by a fine membrane (*1*), which seems to rupture to admit the passage of the rhabdites, whilst underlying this is a stratum containing two or three rows of undoubted nuclei (*2*). What this layer is the condition of the material did not permit me to determine, but many of the nuclei in the particular section shown in the drawing were certainly situated on the filaments described above. It is possible that this layer with its nuclei represents the epidermis, or, together with the basal cells, the dermis.

Figure 2 shows what I conceive to be an early stage in the development of the rhabdites. The "cell" was projecting slightly from the surface of the battery (*1*), and contained two highly refractile rounded bodies—one being very much larger than the other. There can be little doubt, from their general appearance and waxy homogeneous structure, that these bodies are simply secretions of some sort, although of what nature I was unable to determine. This identification was at once independently suggested by the biologists to whom I showed the slides. Besides the larger secretions are two smaller aster secretions, which bear a superficial resemblance to centrosomes but which have not of course any relation to those problematical bodies. One of these asters is connected with the smaller secretion-sphere, which suggests that it may have originated by the fragmentation of that body. The asters are also shown in figs. 4, and 6 *a* & *b*. Beyond that they appear to pursue the same course of development as the rhabdites themselves, that is to say they are formed by the breaking up of an originally spherical secretion-mass, of which the earliest stage I have seen is shown in fig. 4, I have failed to ascertain where they come from or what ultimate rôle they fulfil. The presence, however, of other asters consisting simply of very fine rods with no central

secretion-mass, as shown in figs. 2 and 6 *a*, seems to indicate that they perform the same function as the larger rods, although such explanation does not meet all the facts. They are of fairly frequent, but not of universal occurrence, and they are the only bodies in the rhabdite-"cells" which are of a fairly constant structure and position, and do not vary within wide limits. For the rest, the irregular outline or sac of the "cell" shown in fig. 2 contains a granular substance which seems to be either pure plasma or a more or less slight modification of that substance. It is to be noted that it is more densely granular at the two poles, the base, however, being more granular than the apex. Particular attention must be directed to the fact that in this "cell," as in all the others examined, there is no structure whatever that can with any justification be called a nucleus. I have hence in describing the bodies as rhabdite-cells placed the word cell in inverted commas.

Figure 3, drawn from a single field, illustrates three conditions well:—(1) the variation in position of the "cells"—*d* lying somewhat below the surface, *a* and *b* immediately beneath it, and *c* and *f* completely outside it; (2) the fragmentation of the secretion-mass as shown in *f*, *d*, *g*, and *b*; and (3) the splitting-up of the secretion-mass to form rhabdite-rods, as shown in all except *c*. In the latter we have only the secretion-sphere and a small vacuole—the most undifferentiated rhabdite body that has been seen. In *b*, however, the sphere has fragmented into two pieces—each piece lying apparently in a vacuole (an interesting feature also seen in the rhabdite-cells of certain Turbellaria), and just commencing to split up. Hence the serrated appearance of the periphery of the two pieces. In *g*, *d*, *e*, and *f*, successive stages in the splitting up of the secretion-mass are seen, whilst in *a* the splitting has proceeded so far that a number of rods have been formed connected by a central mass of hitherto undifferentiated secretion. The latter contains a small vacuole (see also fig. 4), whilst outside the clump of rods are two small secretion-masses, which may either be the two aster anlagen or fragments of the original secretion-sphere.

In figure 4 we have a condition intermediate between *f* and *a* of the preceding figure. The secretion-sphere lies in a large vacuole, and the splitting up, though somewhat far advanced, has yet not proceeded as far as in 3 *a*. The central vacuole has been already noticed. Above, at the apex of the "cell," is a bent

plate of secretion which I have not seen in any other "cell," unless it is comparable to the rod in the same position seen in fig. 5. Below are two large asters of a comparatively simple type, and of the usual structure and position. As shown in figs. 3 *a* and 6 *b*, the split secretion-sphere does not always lie in a vacuole.

The rhabdite-"cell" shown in fig. 5 is lying practically outside the battery, the rhabdites have broken away from the central mass, leaving the latter lying in the middle of the "cell." At the base is another mass of secretion, formed doubtless by an antecedent fragmentation of the original sphere. At the apex is a thin transverse rod, perhaps comparable to the curved plate in fig. 4, which I have not seen in any other "cell." The "plasma" does not completely fill the latter. The rhabdites are here practically ready to be discharged, and to the left are seen several free rods formed by the discharge of an adjacent "cell."

Figure 6 shows two contiguous "cells" (lying immediately under the surface) from one field. In *b* we have a stage similar to that in 3 *a*, except that in the former two small asters are present, each lying in a clear space, whilst the splitting of the secretion-sphere has not proceeded so far. In 6 *a*, however, the splitting has resulted in the formation of two kinds of rhabdites —stout and fine. The latter are still adherent to the residue of the sphere and are the more numerous, whilst the former have broken off, may project through the wall of the "cell," and bear evident traces of their origin from such stages as those figured in 6 *b* and 3 *a*. The whole, together with a small aster of 4 rays, lies in a clear space in the "cell," two small asters being embedded in the "plasma."

The "cell" shown in fig. 7 is an almost isolated example of its kind, and no other exactly resembling it was seen *. Empty sacs, however, having faint longitudinal folds, which have been identified by others besides myself as similar bodies that have been discharged, are not uncommon. In the "cell" above, which lay immediately below the surface, the rhabdites were arranged in a definite axial bundle, no small asters were present, there were no clear spaces in the "plasma," and the whole of the secretion had been used up in the formation of the rhabdites—a condition not often seen. This stage may be described as the final one immediately prior to discharge.

* Since writing I have observed others in Prof. Howes' material at the R. College of Science, Lond.

Finally it is necessary to mention another stage which was only of occasional occurrence in the material at my disposal, but which seems to be common in the sections of *Cephalodiscus* in the laboratory of the Royal College of Science. Here the rhabdite-" cells " are sharply divided into two parts, so as to present a strong superficial resemblance to certain of the pseudo-rhabdites described by Bürger in Nemerteans. The upper or apical portion contains a body which undoubtedly corresponds to the secretion-sphere and its products described above. The lower or basal portion is of a uniform, structureless and highly refractile appearance, as if this portion of the " cell " were filled with a homogeneous waxy secretion. I am unable to connect this stage with the others with certainty, but it seems to be an early stage in the formation of the rhabdites, and may possibly be the earliest yet seen in the material. Its occurrence was of too occasional a character in my material to enable me to study it as carefully as the other stages.

The question that now arises is from what source are the rhabdite-" cells " of *Cephalodiscus* derived. That they are portions of cells, and not complete cells in themselves, must be admitted, in view of the fact that they do not possess any structure that may be justifiably interpreted as a nucleus. On the other hand, their position and mode of occurrence is strongly suggestive of the view that they are disassociated portions of the basal cells (fig. 1, *4*) of the battery. These basal cells therefore, on this view, will be constantly giving rise to the so-called rhabdite-" cells," and the latter will as constantly be discharged on to the exterior. The term rhabdite-cell will hence belong properly to the bodies described in this paper + also the basal cells of the battery, since the two together are the morphological equivalent of the Turbellarian rhabdite-cell and its contents.

In order to justify the term I have applied to the structures here described, the following comparison is appended between these bodies and the cells in Turbellaria to which the term rhabdite-cell was first applied by Graff in 1882. Lang * in the Polyclads distinguishes two kinds: (1) Rhabdite-cells; and (2) " Schleim-stäbchenzellen " or Pseudo-rhabdites. Of the former he says (pp. 51–52):—" Der Kern der Stäbchenzellen liegt stets am basalen Ende derselben; das freie distale Ende der Zellen ist mit Flimmerhaaren besetzt, wovon man sich durch Isoliren der

* Fauna u. Flora d. Golfes v. Neapel, Monog. xi. pp. 51–55.

Stäbchenzellen des lebenden Thieres leicht überzeugen kann." The "Flimmerhaaren" I have not seen in *Cephalodiscus*, although it is possible that living material may disclose them. Lang's account of the development of the rhabdites is too long to be quoted *in extenso*, but may be summarized as follows:—Situated in between the mature rhabdite-cells here and there are much smaller cells each containing a nucleus. Lying close to the nucleus is a single small, round, homogeneous, highly refractile body. This body Lang regards as essentially a secretion. It grows and fragments to form a number of small balls, and each ball becoming lengthened and spindle-shaped, forms a rhabdite-rod—the whole of the rods becoming subsequently arranged to form a pyramidal bundle with the base opposed to the nucleus. The rhabdite-cells therefore contain a nucleus, plasma, and the rods. Lang and Graff are agreed that they are gland-cells, and that the rhabdites are their secretion.

The Pseudo-rhabdites of Lang have an uneven periphery. They are figured in some species as one or more tall columns of end to end secretion-fragments (Blöckchen) of an irregular shape, with the nucleus and plasma of the cell lying at its base and under the pseudo-rhabdites. In *Stylochus*, Lang says (pp. 53–54):—"Die einzelnen Blöckchen entsprechen ihrem optischen Verhalten nach sehr den Rhabditen, sie sind klar, homogen, stark lichtbrechend und verhalten sich Farbmitteln gegenüber ganz wie diese. Die Säulen, die sie bilden, erfüllen beinahe die ganze Epithelzelle, in der sie liegen, und lassen höchstens am basalen Theil, wo der Kern liegt, ein Klümpchen feinkörnigen Plasmas frei." Lang considers that the pseudo-rhabdites are fully comparable to the true rhabdites, and describes several stages intermediate between the *Stylochus*-type and the mature rhabdite-cell with its clump of rods.

Just as the pseudo-rhabdite must be regarded as a comparatively simple modification, in which the secretion has not undergone such differentiation as in the true rhabdite-cell, so do certain gland-cells in Nemertea represent a condition antecedent to the pseudo-rhabdite form. Hubrecht * describes and figures in *Cerebratulus* and *Eupolia* unicellular glands which he considers correspond precisely to the pseudo-rhabdites of Lang. They have in *Cerebratulus* highly refractile uniform contents, *not*, *however*,

* 'Challenger' Reports, vol. xix. p. 61.

*divided into blocks.* Bürger* describes other homologous bodies Nemertea as flask-shaped gland-cells.

According to these descriptions there can be little doubt that the bodies described in this paper are similar, in all their essential points of structure and development, to the rhabdites, pseudo-rhabdites, &c. of Turbellaria and Nemertea. We have in fact a complete and gradually ascending series commencing with the comparatively simple cells in Nemertea, and terminating in the complex structures of *Cephalodiscus*. In *Cephalodiscus* they are more differentiated (1) as regards accessory secretions in the cells; (2) as regards the details of the development of the rhabdites; and (3), provided the view stated in this paper be correct, in the separation of the portion containing the secretion from the mother-cell, so that the two become quite distinct.

## Summary.

*Cephalodiscus* has a lophophore of 12 branchial plumes, each of which consists of a central stem or axis with its associated filaments. Each axis becomes enlarged at its distal or free extremity so as to form a conspicuous hollow bulb, the cavity of which is continuous with the cavity of the stem. As the rhabdite-cells are entirely confined to these bulbs, the latter may be conveniently termed rhabdite-batteries. Histologically, the wall of the battery is greatly vacuolated, and contains essentially two series of bodies: (1) a series of large nucleated basal cells; (2) above these a series of non-nucleated bodies lodged in the vacuoles and termed rhabdite-"cells." 1 and 2 together, however, are the equivalent of a rhabdite-cell of a Turbellarian, since 2 possesses no nucleus, and 1 contains no secretion. In fact 2 must be regarded as a disassociated portion of 1. The secretion of 2 is primitively a large homogeneous sphere. This may or may not become fragmented. Subsequently there often arise two small aster secretions of unknown origin, fate, and significance. The sphere of secretion afterwards splits peripherally so as to form, first a star-shaped structure, and then a number of stout free rods. The splitting usually leaves a residue, but the whole of the sphere may be used up in the formation of the rods. The rods have been observed arranged in a definite bundle parallel to the long axis of the "cell." The

* Bronn's Thier-reichs, Bd. iv.

rods and sometimes the whole "cell" may be found lying outside the battery. No two cells are ever structurally identical, and their position varies from one in close proximity to the basal cells to one in which they lie completely outside the battery. Besides the secretion-spheres and their accessories, they contain a granular substance in varying quantity identified as plasma or a modification of that substance. In all essential respects they are comparable to the rhabdite-cells of the Turbellaria (and are hence of the same nature as the pseudo-rhabdites of Nemertea), since their prime object is to secrete rods and then to discharge them on to the exterior.

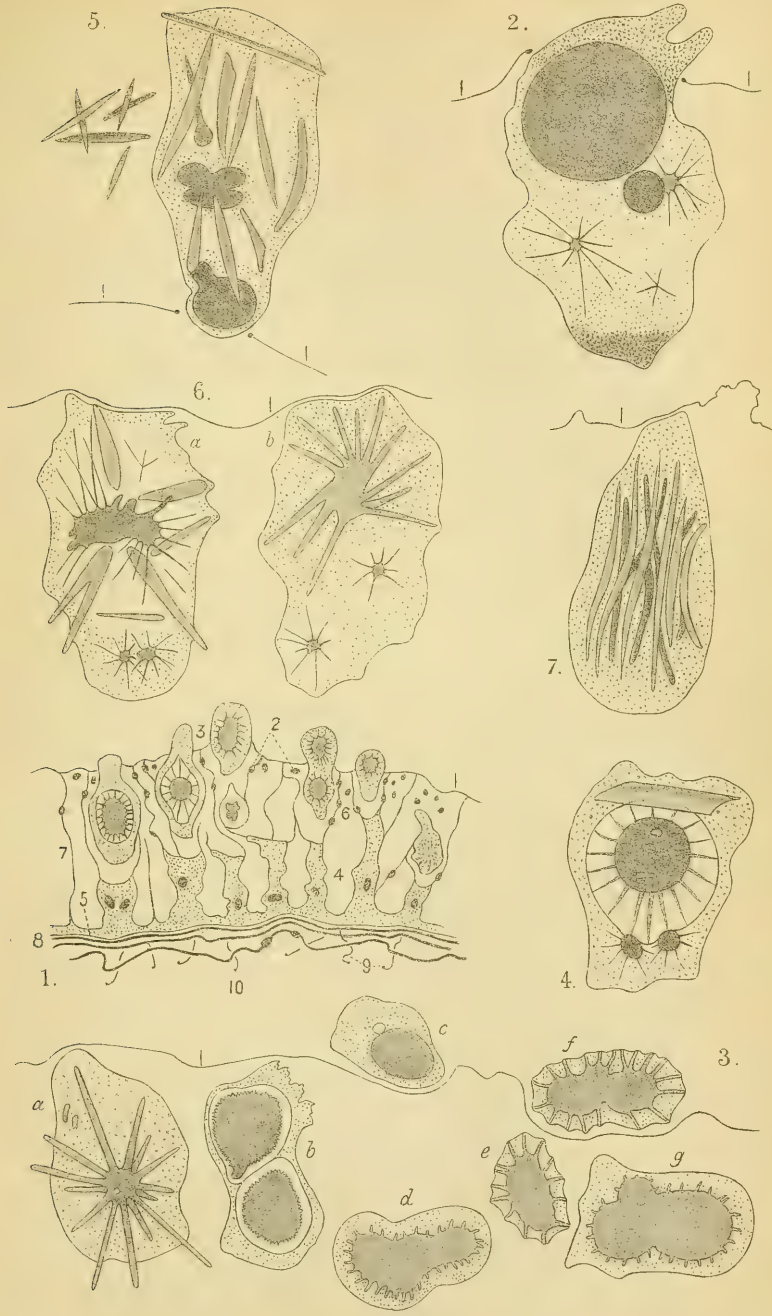
## EXPLANATION OF PLATE 17.

All figures drawn with Zeiss's 1·5 mm. apochromatic lens with the oc. compens. 12.

Fig. 1. Portion of a median longitudinal section through the rhabdite-battery and stem of a branchial plume, showing the structure of a piece of the wall of the battery. Reduced.

*1.* Peripheral membrane.
*2.* Peripheral nuclei situated in the superficial layer of the wall of the battery.
*3.* Rhabdite-"cells" (semi-diagrammatic; note position).
*4.* Basal cells.
*5.* Stratum of protoplasm placing all the basal cells in communication proximally.
*6.* Nucleated filaments from basal cells to periphery.
*7.* „ „ from *5* to periphery.
*8.* Layer of longitudinal fibres (here appearing transverse).
*9.* Fibres of *8* snapped in fixation.
*10.* Cavity of rhabdite-battery (continuous with that of stem).

Figs. 2 to 7. Stages illustrating the development of the rhabdite-rods (arranged as far as possible in order). The "cells" are in all cases represented in the same position, *i. e.*, *1* is the peripheral membrane and above it is the exterior. The "cell" shown in fig. 5, therefore, lies practically outside the battery, and those of fig. 6 lie immediately under the surface.




Cole, del. M'Farlane & Erskine, Lith. Edin.

RHABDITES IN CEPHALODISCUS.